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APHIDS INJURIOUS TO ORCHARD FRUITS, CURRANT, GOOSEBERRY AND GRAPE

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APHIDS are small, delicate, winged or wingless insects which feed upon plant juices, draining them from the foliage, fruit, twigs, or roots, through a beak pushed into the plant tissues.

Many kinds injure orchard fruits, currant, gooseberry and grape. The most important are discussed in this bulletin.

Contact sprays, such as kerosene emulsion, soap washes, nicotine solutions, etc., must be used to kill aphids. Directions for preparing and applying them will be found on pages 34–39.

Stomach poisons, such as arsenate of lead, Paris green, and other arsenicals, are of no use against aphids.

Species which winter in the egg stage on the plants to be protected may be sprayed early in the spring as the buds are expanding, to kill the first brood and insure against injury later in the season.

Leaf-curling species, especially, should be treated with this bud spray in years when they are expected to be abundant. They can not be reached satisfactorily after the leaves have unfolded and the aphids have begun to be troublesome.

Those species which do not curl the leaves may be controlled readily by sprays when they are noted as becoming numerous.

Annual bud spraying in the case of the apple appears to be good orchard practice and, continued for a series of years, doubtless would prove profitable.

APHIDS INJURIOUS TO ORCHARD FRUITS, CURRANT, GOOSEBERRY, AND GRAPE.[1]

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The control of aphids, or plant lice, is an ever recurring problem to the grower of orchard and bush fruits. Although cereal and forage crops furnish perhaps the most striking examples of the destruction wrought by aphids, practically no crop is free from attack by one or more of these small and delicate insects. During the past decade especially, aphid injury to orchard fruits, particularly the apple, has been on the increase.

The present bulletin treats of the aphids injurious to fruit and foliage of apple, quince, pear, plum, cherry, peach, currant, gooseberry, and grape. Thirty-two species of aphids in all are discussed. The more important forms affecting a given fruit are considered first, and then follows a brief account of species known to infest the plant locally or occasionally, and which growers should be able to distinguish from the more destructive species. In their life history aphids are peculiar in many respects, and each species occurs in several different forms; for this reason a short account of aphids in general is given for the information of readers not familiar with these facts. Remedial measures are described at the close of the bulletin, since similar treatments are applicable, with some variations, for the control of all the species considered.

[1] Since the well known grape phylloxera [*Phylloxera vitifoliae* (Fitch)] is injurious principally to the roots and requires control measures radically different from those employed against foliage-inhabiting aphids, it is mentioned only incidentally in this bulletin, although its galls on grape leaves are illustrated (fig. 23, p. 32).

NOTE.—This bulletin is of interest to orchardists, vineyardists, and growers of currants and gooseberries in all parts of the United States.

APHIDS IN GENERAL.

Aphids, or insects of the family Aphididae, have a development which is remarkable in several ways. Eggs laid in the autumn hatch in the spring about the time when vegetation revives. From these winter eggs is produced a generation of females, usually wingless, which reproduce without the intervention of males (agamic reproduction), many species giving birth to living young. The adult aphids of the first generation are termed stem-mothers. The offspring of the stem-mothers (second generation) may be winged or wingless, or both forms may occur. They reproduce without the intervention of males, some species being oviparous, or egg laying, and depositing eggs which do not require fertilization for development, while others are viviparous—that is, they bring forth young alive, the eggs developing and hatching within the body of the parent.

A succession of generations may be produced in this way until the approach of autumn, when the true sexes appear and the females deposits eggs; or a species perhaps may be more or less biennial, some individuals producing true sexes only every second year. In still other species, the true sexes of which are at present unknown, reproduction without the intervention of males continues for a series of years.

The same species of aphid usually exhibits several forms, as wingless agamic females, winged agamic females, and the true sexual forms. In the last the male may be winged and the female wingless, or both sexes may be wingless. The different generations of a given species may vary more or less in appearance, and in some instances this is the case to such an extent that they appear to belong to distinct species.

Aphids feed upon sap which is sucked up through a beak pushed down into the tissues of the plant. Their presence on plants frequently is indicated by a curled and distorted condition of foliage, though this is not always so. When the insects are abundant the drain upon the plant is very great, interfering with its proper growth and development, and in extreme cases causing the death of infested parts. The leaves and shoots of plants infested by aphids are frequently seen to be covered with a black substance, as if dusted with soot. This is due to a black fungus which grows on the "honeydew" excreted by the aphids and is not especially injurious, though often objectionable as marring the appearance of the plants and fruit. Honeydew may be produced in such quantities as to coat the leaves and is attractive to various species of ants and wasps, which are often seen attending the aphids or frequenting plants infested by them. The ants of themselves are not usually the cause of trouble but merely denote the presence of the aphids.

Since frequent reference must be made in the following pages to the different stages and forms of aphids, information concerning these is presented in summary form as far as present purposes require:

Winter eggs.—These are small, oval, and blackish, and occur on the twigs, around buds, under scales of bark, or elsewhere on the shoots or branches of the winter host plant.

Stem-mothers.—The aphids hatching from the winter eggs. They are the progenitors of the numerous generations which follow during the succeeding spring, summer, and fall.

Wingless viviparous females.—Wingless aphids which give birth to living young without the intervention of males.

Winged viviparous females, or migrants.—Winged aphids which give birth to living young without the intervention of males and which migrate to other plants, establishing new colonies. Spring migrants and fall migrants are often to be distinguished.

The true sexes.—Males and sexual females are usually developed in the fall from the viviparous forms, the female depositing eggs to carry the species over the winter.

APPLE APHIDS.

Three or four species of aphids commonly attack the fruit and foliage of the apple, while a few more, which at present are of minor importance, are known to infest this plant. The important species to be considered are the rosy aphis, the green apple aphis, the woolly aphis, the oat or European grain aphis, and the clover aphis.

THE ROSY APHIS.[1]

The rosy aphis infests especially the foliage surrounding the blossom or fruit clusters, and causes the leaves to curl badly. (Fig. 1; fig 2, *b;* illustration on title-page.) The insects when abundant also infest the fruit stalks and newly set fruit. The little apples on the infested fruit spurs often fail to thin out, remain small, and as the season progresses become knotty and distorted according to the degree of infestation. In the fall these "aphis apples" (fig. 3) may be much in evidence, especially on the lower parts of the tree, during worst aphid seasons amounting to from 15 to 30 per cent of the crop. This species is very generally present in the apple-growing portions of the country and is at present the most important aphid pest attacking the foliage and fruit of this crop. On very young trees the feeding habits differ somewhat in that in addition to the foliage the aphids may attack the young shoots, causing these as they grow to become curled and twisted (fig. 2, *c;* fig. 4), resulting in permanent deformities which in pruning must be cut out in order that a properly formed tree may be produced.

[1] *Aphis malifoliae* Fitch.

FIG. 1.—The rosy aphis: Injury to apple foliage and fruit. (Original.)

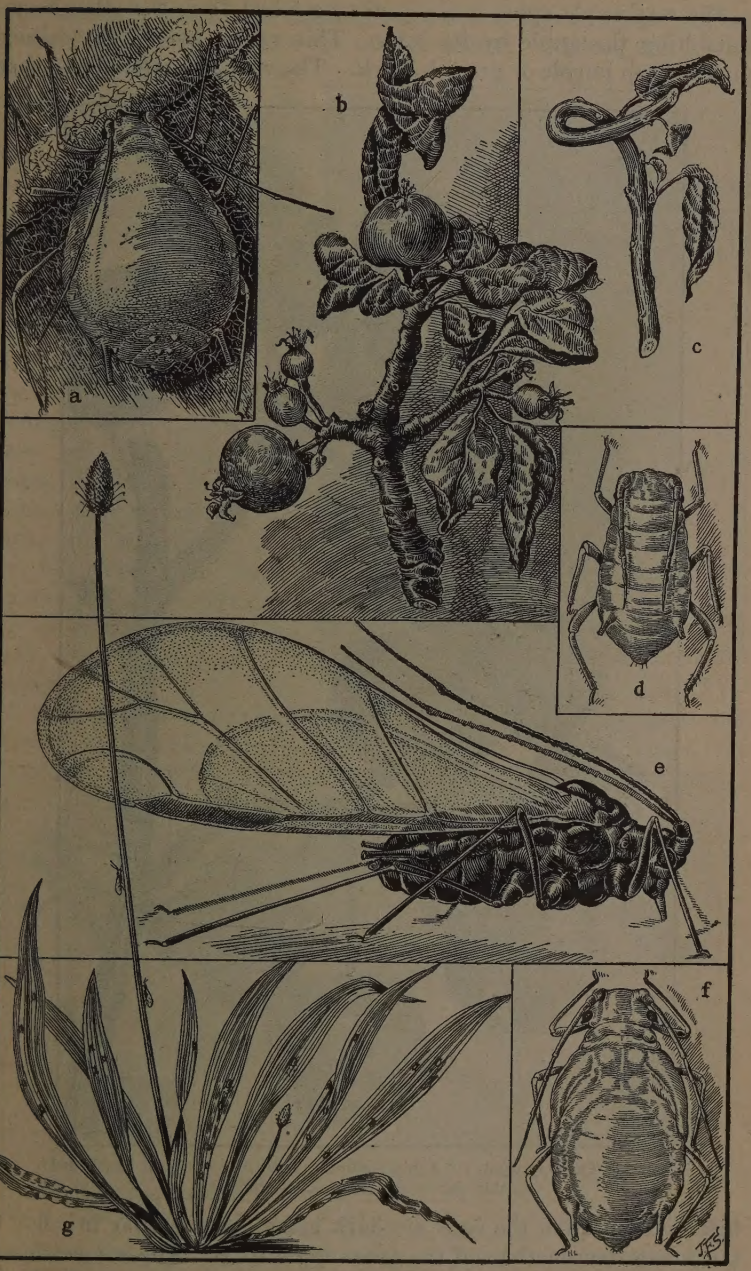

FIG. 2.—The rosy aphis (*Aphis malifoliae*) : *a*, Wingless agamic female ; *b*, injury to fruit and apple foliage ; *c*, injury to apple twig ; *d*, newly born agamic aphid ; *e*, spring migrant ; *f*, pupa of spring migrant ; *g*, rib grass, one of the species of plantain on which the rosy aphis passes the summer. *a*, *d*, *e*, *f*, Greatly enlarged. (Original.)

The rosy apple aphis is easily distinguished from the other forms inhabiting the apple by its color. This varies from light salmon pink to deep purple or grayish black. The young stem-mothers when

FIG. 3.—The rosy aphis: "Aphis apples." Note that the fruit has failed to thin out in the clusters. (Original.)

first hatched from the eggs are dark green, very similar in color to the young stem-mothers of the green apple aphis. The winged forms (fig. 2, *e*) are dark and often appear almost black, owing to the black head and body and the large black patch upon the abdomen. This

is particularly true of the fall migrants, which appear upon the trees in the fall. These produce the orange-yellow, wingless, egg-laying females. The males are winged and similar to the fall migrants. The summer forms occurring upon plantain are yellowish green, with brown patches at the base of the honey tubes.

FIG. 4.—The rosy aphis: Twisted apple twig resulting from injury by this species. (Original.)

SEASONAL HISTORY.

The eggs of this species are deposited on the apple in the fall. They are light yellow when laid and change from green to polished black. They are placed upon the twigs, in the axils of the buds, or in crevices in the bark, but sometimes they are laid upon the larger branches. They begin hatching at about the time the buds are breaking in the spring.

The young stem-mother immediately begins feeding upon the bursting buds, and as the young leaves develop they curl about her.

FIG. 5.—The rosy aphis: Condition of the foliage in spring when leaves curled by this insect are first in evidence. (Original.)

(Fig 5.) Usually in 15 days the stem-mother is mature, whereupon she begins producing young (fig. 2, *d*) at an average of 6 a day. The stem-mother lives from a month to six weeks.

The offspring of the stem-mother may either become winged or remain wingless, and this condition may continue for at least 7 generations, so that during these generations both winged and wingless forms are to be found upon the apple. Occasional colonies of wingless forms (fig. 2, *a*) may be found throughout the summer upon the apple. The winged forms, however (fig. 2, *f*, last immature stage, or pupa; fig. 2, *e*, adult) when mature fly to plantains and settle upon the underside of the leaves, or upon the flower stems, where they produce young (fig. 2, *g*). They live principally upon the species known as rib grass, long-leafed plantain, or buckhorn plantain.[1] This migration to the plantains continues, in the vicinity of Washington, from the middle of May until the first part of July. On the plantains the insects continue to reproduce during the summer months. Most of the forms produced on these plants are wingless, although a few winged ones occur throughout the summer. The color of these forms is yellowish green, in contrast to the pink or rosy color of those upon the apple. From 4 to 14 generations of the summer forms occur upon plantain in the vicinity of Washington.

In the middle of September winged forms, consisting of fall migrants (agamic females) and males, begin to appear upon the plantains. These winged forms are able to live and reproduce only upon apple trees or closely related species. The fall migrants leave the plantains and settle upon the underside of the apple leaves, where they produce the young egg-laying females. These egg-laying females are wingless and pale yellowish. The males, which are similar in color to the fall migrants, often being nearly black, fly from the plantains and find the egg-laying females upon the trees. Here mating takes place and the females deposit their eggs about the middle of October. As later females are produced by later migrants, egg-laying continues until freezing weather has killed all the females.

THE GREEN APPLE APHIS.[2]

The green apple aphis lives on the apple throughout the year, and infests the tender terminal growth, causing the leaves to curl, as shown in figure 6, *a*, and figure 7. In young orchards by midsummer the shoots and leaves of the trees may be more or less generally infested, often so much so as decidedly to check the growth. Such trees are likely to be more or less sooty in appearance and overrun with ants. Water sprouts and the shoots of top-worked trees are especially liable to attack. This is the species commonly present on the shoots of apple nursery stock, and much complained of during some years. The work of this aphid is at times confused with that of the apple leafhopper,[3] which distorts the leaves in a manner more or less similar.

[1] *Plantago lanceolata.* [2] *Aphis pomi* DeGeer. [3] *Empoasca mali* Le Baron.

FIG. 6.—The green apple aphis (*Aphis pomi*): *a*, Injury to apple shoot; *b*, spring migrant; *c*, wingless agamic female; *d*, winter eggs on apple shoot; *e*, pupa of spring migrant. *b*, *c*, and *d* (at right), greatly enlarged. (Original.)

The green apple aphis is uniformly green, with black legs, feelers, and honey tubes. Occasionally forms are met which are yellowish, instead of a distinct green. The winged forms (fig. 6, *b*) have a black head and body and a uniformly green abdomen. The males and egg-laying females, which are met during the fall, are somewhat smaller and different in color from the agamic forms (fig. 6, *c*) which occur throughout the summer. The males are orange yellow, sometimes with a brownish tinge, and the females dark green.

FIG. 7.—The green apple aphis: Curled condition of apple foliage due to this insect. (Original.)

SEASONAL HISTORY.

The eggs when first laid are yellowish green, later turning to polished black. They are laid in the fall upon the smooth twigs and water sprouts of the apple (fig. 6, *d*, fig. 8), and seem to be laid rarely on the trunks and larger limbs. A very small percentage of the eggs of this species, sometimes as low as 2 per cent, hatches. Hatching occurs at about the same date in the spring as in the case of the rosy aphis.

The young stem-mothers mature in about 10 days, and in about 24 hours after becoming adult begin to produce living young, reproduction continuing for about two weeks. Between 40 and 50 living young are produced by each stem-mother, at the average rate of 4 a day, although many more may be born daily. Of these young, some develop into winged forms, or migrants (fig. 6, *c*, *b*), and some remain wingless (fig. 6, *c*). They mature in a little over a week, and in turn produce either winged or wingless forms. Occasionally another form, intermediate between the winged and the wingless forms, is met. This reproduction continues throughout the summer, from 9 to 17 summer generations occurring before the sexual forms

appear. The true sexes, therefore, appear from the tenth to the nineteenth generation, depending upon the rate of reproduction of their ancestors and upon the time of their birth—that is to say, whether they are early or late young of the parents.

The egg-laying females become adult in from 6 to 16 days, depending upon weather conditions. When adult they mate with the males and begin depositing their eggs upon the apple twigs. Females may be found on the trees until all the leaves have fallen, even when the weather is very cold.

FIG. 8.—The green apple aphis: Winter eggs on apple twig. Much enlarged. (Original.)

THE OAT APHIS.[1]

The oat aphis, sometimes called the European grain aphis, is the earliest apple aphid to hatch in the spring; and as it often occurs in great abundance upon the buds and young foliage, it is frequently the cause of alarm on the part of orchardists. The species probably does not cause important injury, since it migrates from the apple shortly after the blossoms fall.

When first hatched the stem-mothers are very dark green, and they remain this color until after the first molt, when they become much paler. The adult wingless forms are pale green, with rusty areas around the base of the honey tubes, although in the summer some individuals become slightly purplish. The winged forms have black head and body with a green abdomen which is marked with black patches along the sides. The honey tubes, antennæ, and feet are black. The egg-laying females, which occur in the fall, have an olive cast.

SEASONAL HISTORY.

During warm days in winter many of the eggs of this species hatch on the

[1] *Aphis avenae* Fab.

trees, but it is not until about the middle of March, in the vicinity of Washington, that those hatching succeed in escaping destruction and produce stem-mothers. In fact, aphids from eggs hatched before April 1 are sometimes all killed by cold. The important hatching, therefore, commences after April 1.

FIG. 9.—The oat aphis: Young stem-mothers clustered on opening apple bud. Much enlarged. (Original.)

The young stem-mothers of this species usually are abundant upon the swelling apple buds (fig. 9), and when these begin to open the insects crowd down among the bursting leaves. By the time the stem-mothers are adult—usually in about 13 days—many of the buds have opened and the leaves expanded. Each stem-mother produces about 100 young, and these migrate to the underside of the leaves, which become coated with them. These young may become either winged (fig. 11) or wingless adults (fig. 10), and at least four generations may be produced upon the apple. The wingless forms upon apple become mature in about seven days, and each individual produces about 75 young. The period of reproduction lasts a little over two weeks, and the insects live about a month.

FIG. 10.—The oat aphis (*Aphis avenae*): Wingless agamic female, greatly enlarged. *a*. Antenna of same, still more enlarged. (Davis.)

The winged forms produced upon apples become mature in a little over 8 days and then fly to grains and grasses, as wheat, oats, etc.

In the autumn migrants are produced on grains. These mature in about 2 weeks and return to the apple, the migration lasting 3 or 4 weeks, since not all the migrants are produced in the same gen-

FIG. 11.—The oat aphis: Winged agamic female, greatly enlarged. *a*, Antenna of same, still more enlarged. (Davis.)

eration. During their life of some 6 weeks these migrants produce about 5 egg-laying females each.

The winged males are produced upon the summer food plants and migrate to the apple leaves to mate with the sexual females. After the female has become fertilized she deposits her eggs in crevices of the bark of the larger branches or behind the bud scales of the young twigs of the apple. (Fig. 12.) The length of life of each sex depends upon weather conditions. This is particularly true of the female, which sometimes lives for weeks in a more or less dormant state during cold weather. In warm climates the species may hibernate as wingless females upon the summer hosts.

FIG. 12.—The oat aphis: Winter eggs on bark of apple tree. Much enlarged. (Original.)

THE CLOVER APHIS.[1]

The clover aphis, first found injurious to the apple in Colorado, is now known to occur abundantly in some regions in the East. It attacks the apple in a way similar to the green apple aphis, but since there is a considerable migration of individuals to clover, it is less abundant on the apple in summer than the latter species. The stem-mothers of the clover aphis are pink and the individuals of the next generation are yellowish green. The winged forms have a large black patch on the abdomen and in this way resemble the

[1] *Aphis bakeri* Cowan.

migrants of the rosy aphis. The two species, however, can be distinguished readily by the length of the honey tubes. In the rosy aphis these are very long, while in the clover aphis they are short. The forms of this species which live on clover are pink.

FIG. 13.—The woolly apple aphis (*Eriosoma lanigerum*): Colonies on apple shoots. (Original.)

SEASONAL HISTORY.

The eggs of the clover aphis are laid upon the apple in much the same manner as those of the species already mentioned. The stem-mothers, which are hatched considerably earlier than those of the rosy aphis and the green apple aphis, give birth to winged and wingless forms, which in turn produce young, some of which become winged, while the others remain wingless. As a rule most of the insects have become winged by early summer, although some wingless colonies occur during the summer on apple. These winged forms fly to clovers, and settling upon the stems produce wingless young. These and succeeding generations, which may contain winged individuals, pass down to the crown of the clover plants, and here the species lives throughout the summer. During October numerous fall migrants are produced upon the clovers and fly to the apple, where they give birth to the young egg-laying females. Winged males produced upon the clovers follow the fall migrants to the apple, and here mate with the females, which later deposit their eggs.

THE WOOLLY APPLE APHIS.[1]

The woolly apple aphis is often in evidence in summer on the trunk, branches, and twigs of the apple as bluish white cottony patches (fig. 13) which hide the rusty or purplish brown aphids beneath.

[1] *Eriosoma lanigerum* (Hausm.)

While principally injurious to the roots of the apple, its injuries above ground are at times quite important. In orchards grown under arid or semiarid conditions in the West it is decidedly more troublesome than in the East, attacking the tree wherever the bark is tender and sometimes infesting the stems of the leaves and fruit. Its injuries above ground often result in galls or swellings similar to those on the roots, and when the fruit spurs are invaded (fig. 14) the fruiting capacity of the tree may be interfered with seriously. The usual contact sprays will be effective in destroying this pest on the limbs and branches. Its treatment on the roots of the apple requires essentially different methods, which are not considered in this bulletin.

FIG. 14.—The woolly apple aphis: Injury to fruit spurs of apple. (Original.)

APPLE APHIDS OF MINOR IMPORTANCE.

Several additional species of aphids are found upon the apple, but these are at present of minor economic importance.

The potato aphis[1] has been found feeding upon apples occasionally in the spring. Its normal winter host appears to be the rose. This form is very much larger than the others mentioned, and the winged forms, as well as the wingless one, is uniformly light greenish.

Another species, which is slaty blue or black, with white bands upon the legs, and often possesses white waxy tufts, occurs sometimes upon the apple. This is the dock aphis.[2] The apple does not seem to furnish suitable food to these insects, for after a few generations they always leave the trees.

[1] *Macrosiphum solanifoliae* (Ashm.). [2] *Aphis rumicis* L.

A second dark brown or blackish species which occurs occasionally upon apples is the bur-clover aphis.[1] It is sometimes met during the spring upon apple foliage.

Still another species, the wild-carrot aphis,[2] occurs commonly on the apple in the fall, particularly as the winged form. Its summer hosts are the wild carrot and related plants, and the winged forms fly to honeysuckles, but occasionally select apples.

The thorn-leaf aphis[3] also is found occasionally upon apple. Its life history is discussed under aphids attacking the quince.

QUINCE APHIDS.

Two species of aphids which have been discussed under apple occur commonly also upon quince foliage—namely, the green apple aphis and the oat aphis. Their life histories are similar on quince and apple, and the same remedial measures apply.

THE THORN-LEAF APHIS.

The thorn-leaf aphis,[3] called also the long-beaked clover aphis, is most common upon hawthorn trees. Although first found upon thorn, it is not uncommon upon quince leaves. It resembles very closely the clover aphis as found upon apple, but can be distinguished from that insect by its long beak.

On thorn trees the feeding of this species results in a curling of the leaves which is very conspicuous, the twisted leaves taking on a purplish cast. On quinces, however, it does not curl the leaves, or at least not to such an extent.

SEASONAL HISTORY.

The eggs of this insect are laid in the fall upon the twigs of the quince, and the stem-mothers hatch in the early spring. By early summer the insects are abundant and winged forms are being produced. This production of winged forms, or migrants, continues until late summer. The migrants fly from their winter hosts to clovers and peas and produce numerous generations on these plants in a manner very similar to that of the clover aphis. In the fall, migrants are produced which return to the quinces and produce the egg-laying females, which after mating with the males deposit the winter eggs. The flight of the insects from clover begins in September and extends throughout October.

PEAR APHIDS ATTACKING THE FOLIAGE.

Several species of aphids are found upon pear foliage. Most of these, however, occur also upon other trees and are treated elsewhere

[1] *Aphis medicaginis* Koch.
[2] *Hyadaphis xylostei* (Schrank).
[3] *Aphis crataegifoliae* Fitch.

in this bulletin. The more common forms upon pear are the green apple aphis, the oat aphis, and the clover aphis.

Another species, the woolly thorn aphis[1] is common in some localities. Both winged and wingless forms are covered with a white waxy substance. The wingless forms are pale green and the winged forms have a black head and body. The insects hatch in the early spring and soon attack the leaves, curling and twisting them. During early summer the winged forms leave the pear tree. In the fall migrants may be found again, and these produce the sexual forms, the females of which lay their eggs upon the bark. Besides pear, this species occurs upon thorn, quince, and Juneberry.

Two other forms are found commonly upon pear, but these occur upon the roots, and since they are seldom found upon the branches and foliage and require different remedial measures, they are not treated in this bulletin. The first of these is the woolly pear aphis,[2] which is common in the western part of the country, and the second is Fitch's pear root aphis,[3] which is very similar to the woolly thorn aphis and occurs in the eastern United States.

PLUM APHIDS.

Three or four species of aphids are common on the plum, two of which are, during some seasons, very injurious. Many complaints of injury to Japanese and native plums by the rusty plum aphis have come from the more southern States, while the mealy plum aphis is more often prevalent in the North and West, on Domestica, or the European type of plums. The hop aphis, according to records of the Bureau of Entomology, has not occasioned much injury to plums in recent years, although in the Pacific Northwest it continues to be a pest of importance to hops.

THE RUSTY PLUM APHIS.[4]

The rusty plum aphis was discovered and named from individuals feeding on grass, but is better known by its injuries to plums. It is rusty brown or deep purplish, with white bands upon the legs.

This species feeds upon the tender twigs and foliage of the plum and also upon the peach. The first stem-mothers attack the buds just as they are expanding in the spring and later crawl down among the opening leaves. As the season advances whole twigs or small branches may be literally crowded with the aphids (fig. 15), and such twigs usually die. Another species, not yet named, also has this habit, and this form may be very injurious to the twigs, as it remains on the plum throughout the summer.

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[1] *Prociphilus corrugatans* (Sirrine).
[2] *Eriosoma pyricola* B. & D.
[3] *Prociphilus pyri* (Fitch).
[4] *Aphis setariae* Thos.

SEASONAL HISTORY.

The eggs of the rusty plum aphis hatch early in the spring and the normal life period of the stem-mother is about a month. During this time she produces young at the rate of four to six a day. In a little over a week these young are mature and reproducing, so that large colonies soon result. A few winged forms occur in the early generations, but it is not until late spring that a large percentage of spring migrants is found. These winged forms fly from the plum and settle upon various grasses, where they produce colonies throughout the summer around the crowns of the plants. In October the fall migrants are produced upon the grasses, return to the plum, and there give birth to the egg-laying wingless females. The males, also produced upon the grasses, migrate to the plum in order to locate and fertilize the egg-laying females. In some regions the species seemingly lives on the plum throughout the year.

FIG. 15.—The rusty plum aphis (*Aphis setariae*): Colony on shoot and foliage of plum. (Original.)

THE LONG-BEAKED THISTLE APHIS.[1]

In some localities the long-beaked thistle aphis is abundant on plum trees. In structure this species most closely resembles the rusty plum aphis. The insects are shiny green and black, some of the wingless ones and all of the winged ones having a large black patch on the abdomen.

Although this species becomes very abundant on the trees, it does not curl the leaves to any extent. Trees have been observed in the vicinity of Washington with the underside of nearly every leaf thickly covered with the insects, and yet these leaves were rolled only slightly from the edges. The insects always feed on the underside

[1] *Aphis cardui* L.

of the leaves or on the very tender twigs. Practically all the injury done to the trees is by the spring forms, the fall migrants being scattered.

SEASONAL HISTORY.

The eggs of this species are laid upon the plum, as are those of the rusty plum aphis. In the early spring the stem-mother hatches and gives birth to living young. Winged forms begin to appear as early as the second generation and continue to be produced until midsummer. These migrate to thistles, where they produce the first of the summer forms. After having produced numerous generations on the thistle during the summer, fall migrants are produced which return to the plum trees to deposit the young egg-laying females. These, after being fertilized by the males, lay the winter eggs.

THE WATER-LILY APHIS.[1]

Plum trees are sometimes thickly infested by an aphid with swollen honey tubes, the water-lily aphis. The insects are brownish, the winged forms having a black head and body.

The spring forms feed upon the underside of the leaves or on the tender twigs of the plums, but they do not curl the leaves to any extent. The summer feeding habits of the species on water plants are very interesting, as colonies often are partially submerged for some time without apparent injury.

SEASONAL HISTORY.

The stem-mothers of this species hatch early in the spring upon the plum, and soon the young produced cover the lower side of the leaves and the twigs. Winged forms are found during June and these fly to various water plants, on which they reproduce and live during the summer months. In the fall the migrants return to the plum and produce the egg-laying females, which, when adult, are fertilized by the winged males. The flight of the fall migrants and males extends over a long period, the males having been found on the plum trees from early until late fall.

THE HOP APHIS.[2]

A large green aphid, the hop aphis, is in some regions very common upon plums in the spring. The wingless forms are light green and the winged forms are light green with black head and body and a patch of the same color on the abdomen.

The stem-mothers of this species feed upon both the flower buds and the leaf buds of the plum. After the leaves have expanded the insects attack the underside of the leaves and often may be found thickly crowded thereon.

[1] *Siphocoryne nymphaeae* (L.). [2] *Phorodon humuli* (Schrank).

SEASONAL HISTORY.

The eggs hatch on the plum twigs considerably later as a rule than those of the thistle aphis. The young stem-mothers soon develop and begin the production of young. Winged forms soon appear, the greater number of these occurring in the third generation. These winged forms fly to hop vines, where they produce young that feed upon the hop plant. Eight or more generations of these summer forms are produced upon the hop, and winged fall migrants are then produced, which return to the plum trees to produce the sexual females. Males appear during the fall for a period of several weeks, the last ones usually occurring late in October or in November. These fertilize the egg-laying females, which then lay their eggs upon the twigs.

In some cases the species is able to complete its life cycle on the hop and does not necessarily alternate with the plum, whereas in other cases it remains all summer upon the plums.

THE MEALY PLUM APHIS.[1]

The mealy plum aphis is a common form on plum trees and it can be distinguished from the other species attacking plum foliage by its uniform green color and the fine, white, powdery covering of the body. The honey tubes also differ in that they are very short.

These insects feed upon the underside of the leaves, often being very closely packed together. (Fig. 16.) As a rule they do not curl the leaves, even when present in great numbers.

SEASONAL HISTORY.

The stem-mothers of this species hatch from the winter eggs on the plum early in the spring and in about 10 days they are mature. They then give birth to young, and these when grown produce others until the leaves are often thickly covered with the insects. Winged forms develop toward late spring and continue to appear until late midsummer or later. These winged forms migrate to certain grasses and produce numerous generations during the summer. In the fall return migrants are produced, which give birth to the egg-laying forms on the plums. These migrants first appear in early September, but continue to arrive until late October or early November.

CHERRY APHIDS.

THE BLACK CHERRY APHIS.[2]

The black cherry aphis is an abundant species almost everywhere upon cherry trees. The wingless insects have a rounded abdomen, which gives them a more or less globular appearance. Both wing-

[1] *Hyalopterus arundinis* (Fab.). [2] *Myzus cerasi* (Fab.).

less and winged forms are shining deep brown to black, while the color of the young ranges from amber through various shades of brown. The young stem-mothers are deep greenish.

On account of their early hatching in spring the young stem-mothers do not find leaf food available. They therefore attack

FIG. 16.—The mealy plum aphis (*Hyalopterus arundinis*) : Infested plum foliage. (Original.)

the buds even before these show any signs of bursting. Sometimes the stem-mothers will feed in this manner for nearly a week before the buds begin to open. As soon as the leaves are formed the young insects attack them and cause them to curl. As they spread from leaf to leaf a large and conspicuous cluster of curled-up leaves (fig 17) is formed, within which the insects feed.

SEASONAL HISTORY.

The eggs are laid upon the cherry twigs in the fall and hatch early in the spring. The insects are able to withstand freezing weather, and after the return of warmer weather continue their activities. Within two or three weeks after hatching the stem-mothers are mature and produce young. These later generations become adult usually in less than a week. Some of the insects so produced become winged while others remain wingless. The winged ones migrate to some plant not known, and here the species lives throughout the summer. The wingless ones continue reproduction, and sometimes give rise to as many as 11 generations before the end of July. The numbers on cherry, however, gradually diminish, and during midsummer very few are seen upon the trees, and in some cases no insects can be found upon trees which earlier in the season were badly infested. During October fall migrants and winged males may be found returning to cherry trees and are often encountered during the migration period in larger numbers than might be expected. The fall migrants produce the egg-laying females which, when mature, are fertilized by the males.

FIG. 17.—The black cherry aphis (*Myzus cerasi*): Curled terminal cherry leaves following attack by this species. (Original.)

THE CHOKECHERRY APHIS.[1]

The chokecherry aphis is found abundantly upon chokecherries and related trees. It is a pale green insect and is conspicuously mealy. The winged forms have a black head and body.

The feeding habits of this species are very similar to those of the black cherry aphis. The leaves of the terminal twigs are attacked and twisted by the feeding of the insects, entire twigs sometimes being destroyed.

As in the case of the black cherry aphis, the eggs of this insect are laid on the cherry twigs. After the stem-mothers have become mature and produced young, these latter crowd the terminal leaves. Winged forms are produced during early summer, and by midsummer the insects usually have disappeared from the trees. Their summer host is not known, but in the fall migrants return to the cherry trees to deposit the egg-laying females.

PEACH APHIDS.

THE GREEN PEACH APHIS.[2]

The green peach aphis is a common form upon peach trees. The stem-mothers in spring, as well as the fall egg-laying females, are

FIG. 18.—The green peach aphis (*Rhopalosiphum persicae*): Colony on underside of peach leaves. Much enlarged. (Original.)

often pinkish, and at other times light green. The wingless agamic form also is light green, while the winged individuals have a black head and body and a large dark-brown patch on the abdomen. This marking occurs upon both the spring migrant and the fall migrant. They are similar in other respects excepting that the fall form has the honey tubes somewhat swollen.

On the peach this species feeds entirely upon the leaves, on which the insects may be found in large numbers crowded on the underside. (Fig. 18.) It has a large number of other food plants, including numerous garden vegetables.

[1] *Aphis cerasifoliae* Fitch.

[2] *Rhopalosiphum persicae* (Sulz.).

SEASONAL HISTORY.

The eggs of this aphid are laid upon the peach twigs, and early in the spring before the buds are opened the green stem-mothers are hatched. From this form during the spring may be produced one or more generations of wingless individuals upon the leaves. Spring migrants, however, begin to occur very early and continue to appear until the middle of June. These fly to a large number of different plants, where numerous generations occur throughout the summer. During September and October fall migrants are developed which return to the peach, where they deposit the young egg-laying females. These are fertilized by the winged males, which also have returned to the peach, and the females then lay their eggs upon the twigs. Occasionally, however, migrants are found which do not return to the peach and these deposit egg-laying females upon the summer host plants.

FIG. 19.—The black peach aphis (*Aphis persicae-nigcr*): Colonies on peach shoot in early spring. (Original.)

THE BLACK PEACH APHIS.[1]

The well-known black peach aphis is injurious to the twigs, shoots, and roots. It is shiny dark brown to black, with the young an amber color.

The insect lives throughout the year on the roots of the peach and is most injurious to peach growing on sandy soils. It is prevalent in portions of Maryland and in Delaware, New Jersey, and Michigan. Individuals migrate from the roots during the warm periods in winter or in early spring and start colonies on the twigs and young shoots. (Fig. 19.) Often these become so numerous as to cause the

[1] *Aphis persicae-niger* Smith.

death of dormant-budded nursery trees (fig. 20) and do serious or fatal injury to young orchard trees. In mild climates the insects may exist all winter on the twigs, reproducing during periods of warmth, though the twigs are for the most part reinfested each year from the insects below the soil.

The complaints of serious injury by this species on the roots of orchard peach trees, in the experience of the writers, have not been justified, the unthrifty condition of the trees being in most cases due to other causes.

FIG. 20.—The black peach aphis: Injury to dormant-budded peach nursery stock in the spring. (Original.)

SEASONAL HISTORY.

The complete seasonal history of this species is not known. The number of young produced by a given parent varies greatly, depending upon weather conditions. Sometimes only one young aphis a day will be produced, with a total of 25 or 30 young to a mother, while under favorable conditions as many as 12 young may be produced in a day and considerably over 100 as the total for a given parent. In spring large numbers of winged forms appear and the percentage of these gradually increases until all of the forms above ground have become winged. These fly to some plant or plants not known and are not met on peach foliage until the next year.

CURRANT AND GOOSEBERRY APHIDS.

THE CURRANT APHIS.[1]

The currant aphis is distributed over the entire country and its injury, on account of its conspicuousness, is the occasion of much complaint. The insect causes the terminal leaves to become much

[1] *Myzus ribis* (L.).

distorted, and little pits or pockets are formed on the underside. (See fig. 21, *b;* fig. 22.) The upper surface of the leaves assumes a more or less reddish color, evident some distance away. When the plants are badly infested these leaves fall and the fruit becomes poor and ripens prematurely. Red currants are most subject to attack, but black currants and gooseberries also are injured.

The stem-mothers of the species are green, the other wingless forms (fig. 21, *a*) a yellowish green, while the winged ones have a black head and body and a large black patch on the abdomen. The eggs are polished black.

SEASONAL HISTORY.

The stem-mothers hatch from the eggs in the early spring soon after the leaves open. After completing their growth they produce young aphids which infest the lower surface of the leaves. Some of the offspring of the stem-mother are winged and these fly to some unknown host. The wingless ones remain upon the currants and continue reproduction. In each generation some winged forms occur, but wingless individuals are present until late in July upon the currants. In fact, occasional colonies remain throughout the summer. In the fall, during early October, migrants return to the currant bushes and deposit the sexual females. These when mature are fertilized by the winged males and the eggs are laid upon the twigs.

THE SOW-THISTLE APHIS.[1]

The sow-thistle aphis is at times quite as abundant on currants as is the currant aphis. It is somewhat similar in color but can be distinguished at once from the currant aphis by the swollen honey tubes. (Fig. 21, *c.*) In the currant aphis these are long and very slender. (Fig. 21, *a.*) The eggs are polished black. The sow-thistle aphis injures the currant in about the same way as does the currant aphis, though the infested leaves (fig. 21, *d*) do not take on a reddish coloration.

SEASONAL HISTORY.

The seasonal history of this species upon currants is very similar to that of the currant aphis. The winged forms, however, migrate to the sow thistle and upon this they reproduce. After the production of numerous generations here during the summer, fall migrants are developed which return to the currants. Egg-laying females are then produced and these are fertilized by the winged males. The eggs are laid upon the twigs at about the same time as those of the currant aphis.

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[1] *Rhopalosiphum lactucae* (Kalt.).

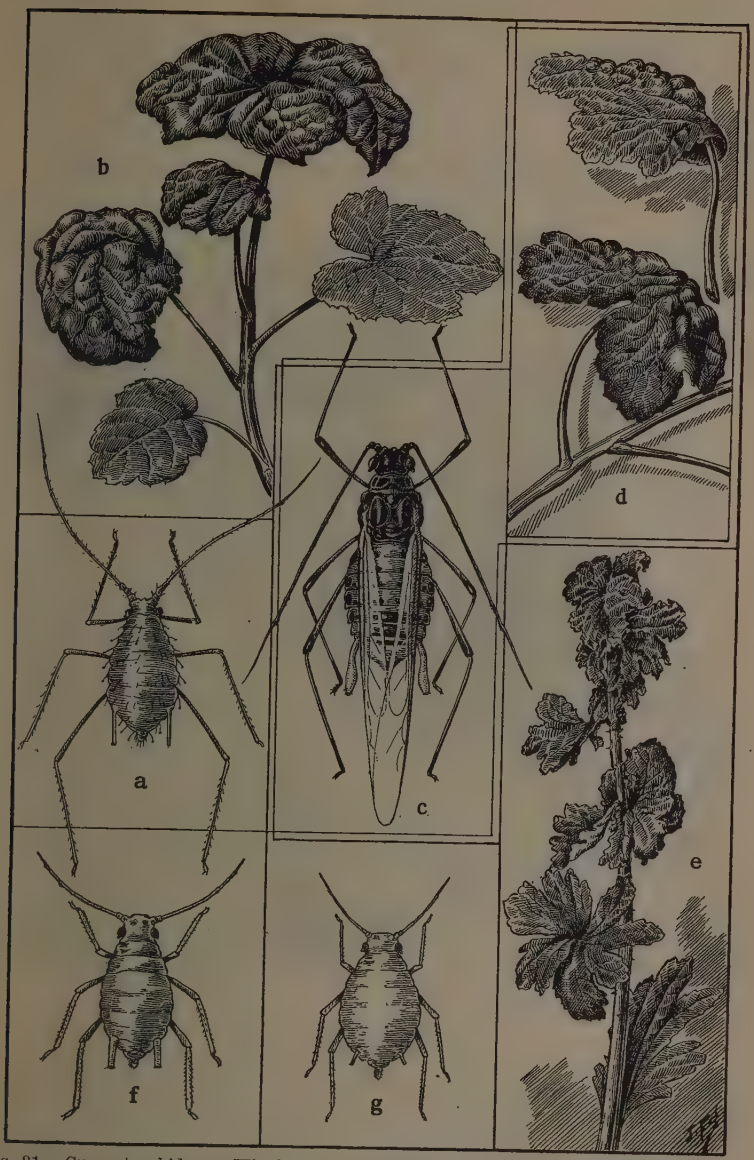

FIG. 21.—Currant aphids: *a*, Wingless agamic female of the currant aphis (*Myzus ribis*); *b*, distorted currant foliage due to attack of this species; *c*, spring migrant of the sow-thistle aphis (*Rhopalosiphum lactucae*); *d*, injury to currant by this species; *e*, work of the green gooseberry aphis (*Aphis sanborni*) on gooseberry; *f*, wingless agamic female of the New Mexico gooseberry aphis (*Aphis neomexicanus*); *g*, wingless agamic female of Sanborn's currant aphis (*Aphis ribis*). *a*, *c*, *f*, *g*, Greatly enlarged. (Original.)

THE GREEN CURRANT APHIS.[1]

A species which may be called the green currant aphis has for years been confused with the currant aphis, which it resembles closely. The wingless forms of the present species are green, whereas those of the currant aphis are yellowish. The life history, so far as is known, is very like that of the currant aphis and the two forms often may be found on the same leaf.

FIG. 22.—The currant aphis: Injury to currant foliage. (Original.)

THE VARIABLE CURRANT APHIS.[2]

The variable currant aphis is one of the most injurious species. The stem-mother is purplish green with white honey tubes. The wingless form is dark green, tan, or dark brown, whereas the winged form has a black head and body, with a dark green abdomen marked near the tip and on the sides with black.

As soon as the stem-mother begins to feed, the young leaf begins curling about her. As young are produced other leaves are attacked

[1] *Myzus dispar* Patch. [2] *Aphis varians* Patch.

until large irregular bunches of twisted leaves occur. Later the insects attack the shoots, sometimes thickly covering them. The species infests currants, gooseberries, and flowering currants.

SEASONAL HISTORY.

The stem-mother hatches from the eggs early in the spring and becomes mature early in May. She produces young which are all wingless. These in turn produce young which may or may not be winged. The winged ones take flight to some unknown summer host, while the wingless ones continue the infestation upon the currants until nearly midsummer. In the fall migrants return to the currants and produce young which develop into males and egg-laying females, the latter depositing eggs upon the twigs.

THE GREEN GOOSEBERRY APHIS.[1]

The green gooseberry aphis is a green species with white honey tubes. It lives upon the underside of gooseberry leaves, which it deforms badly (fig. 21, *e*), and also upon the twigs.

The seasonal history of this species has not been determined. The winter eggs are laid upon the host plant upon which the stem-mother develops. Wingless forms occur later than the stem-mother, and winged ones also are produced upon the gooseberry.

THE HOUGHTON GOOSEBERRY APHIS.[2]

A pale green species is sometimes found curling the leaves of Houghton gooseberries. The winged forms are somewhat darker than the wingless ones. The life history of the species is unknown.

THE NEW MEXICO GOOSEBERRY APHIS.[3]

Another species is found on gooseberries in New Mexico. The wingless forms (fig. 21, *f*) are green, while the winged forms have black head and body, with green abdomen marked with some dark bands or spots. Its life history is unknown. A variety of this species is found in California, feeding upon the red currant.

SANBORN'S CURRANT APHIS.[4]

A small species of aphid occurs in the Middle West and Southwest on Missouri gooseberries and cultivated currants. This is Sanborn's currant aphis. The wingless forms (fig. 21, *g*) are green, and the winged forms have black head, body, legs, honey tubes, and antennæ. The species is found in the spring in rather large colonies on the underside of the leaves, which it causes to curl and twist.

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[1] *Aphis sanborni* Patch.
[2] *Aphis houghtonensis* Troop.
[3] *Aphis neomexicanus* (Ckll.).
[4] *Aphis ribis* Sanborn.

GRAPE APHIDS ATTACKING THE FOLIAGE.

The well-known grape phylloxera occurs in some localities upon grape foliage (fig. 23), but this species is not treated in this bulletin,

FIG. 23.—Galls of grape phylloxera (*Phylloxera vitifoliae*) on grape leaf. (Original.)

since it is injurious principally to the roots and requires control measures radically different from those employed against foliage-inhabiting species.

THE GRAPEVINE APHIS.[1]

The grapevine aphis is very numerous in some localities, infesting the tender shoots and leaves (fig. 24) and sometimes the fruit clusters, causing the berries to drop. It can be distinguished easily from any other forms occurring upon grape by its large size and its dark-brown color.

FIG. 24.—The grapevine aphis (*Macrosiphum illinoiensis*): Colony on grape shoot. (Original.)

SEASONAL HISTORY.

The eggs of this species are laid upon the twigs of the black haw (*Viburnum prunifolium*). Very early in the spring they begin hatching, but these first stem-mothers may be killed by frost. Six or eight weeks later the aphids of the second generation mature, and these nearly all become winged. These migrants fly to the grape and produce young upon the tender growing shoots, where in less than 10 days they are mature and producing young. Reproduction on the grape continues throughout the summer, and often more than a dozen generations may occur. In each generation winged forms are found, and these carry the infestation to new vines. During October fall migrants are produced, which return to the haw trees and deposit the egg-laying females. When mature these are fertilized by the winged males which follow the fall migrants, and egg laying follows.

NATURAL ENEMIES OF APHIDS.

Aphids are attacked by various species of parasitic and predacious insects and by fungous diseases, and these agencies exert a very im-

[1] *Macrosiphum illinoiensis* (Shimer).

portant influence in their control. The combined effect of these several factors normally keeps the aphids pretty well reduced, but when for any reason their activities are lessened the aphids may increase enormously and do a widespread injury. Heavy driving rains are believed to be inimical to aphids, whereas cool, cloudy weather seems to reduce the activities of the parasitic and predacious enemies, permitting the aphids to become correspondingly abundant.

FIG. 25.—The convergent ladybird (*Hippodamia convergens*), an enemy of orchard aphids: *a*, Adult; *b*, pupa; *c*, larva. Enlarged. (Chittenden.)

Ladybird beetles (fig. 25) may be found in almost any colony of aphids, both the beetles and larvæ feeding freely on the insects. Numerous species of these beetles attack the aphids, and they should be protected and encouraged when possible.

Larvæ, or maggots, of syrphus flies, also called sweat flies (figs. 26 and 27), are very generally present in aphid colonies and are most important checks to their increase.

The larvæ of two or three species of lacewing flies feed freely on aphids, although they are not so important as the insects mentioned above.

Probably the most important check to aphid increase, however, is the work of certain minute, four-winged flies which live parasitically on the aphids. These multiply very rapidly and under normal conditions are very effective. The bodies of parasitized aphids usually become enlarged, assume a more or less globular shape, and finally show the exit hole of the adult parasite. (Fig. 28.)

FIG. 26.—Larva of the syrphid fly *Allograpta obliqua*, an important enemy of aphids. Much enlarged. (Metcalf.)

CONTROL MEASURES.

As previously stated, aphids feed upon plant juices which they obtain by means of a beak inserted into the plant tissues. Paris green, arsenate of lead, and other arsenicals, or stomach poisons, are therefore ineffective against these insects, and the so-called contact sprays, such as kerosene emulsion, soap washes, nicotine sprays, etc., must be employed. These sprays, to be effective, must come in contact with the bodies of the insects, and great thoroughness in spraying is necessary.

Two principal plans of attack may be followed in the control of orchard aphids. Those species which winter in the egg stage on the plants to be protected may be treated with sprays early in the spring as the buds are expanding, to destroy the young stem-mothers. Treatment at this time assumes that without it the aphids would become injurious later in the season and is in the nature of insurance.

Following the other plan, spraying is not done until the insects actually have become troublesome, which does not occur as a rule until several weeks after the foliage has put out. With species that cause the leaves to curl this is too late to obtain much benefit from spraying. In view of the more or less scattered occurrence of aphids many growers will prefer to delay treatment until the insects actually are present on the plants in destructive numbers, and in the case of those species which do not curl the leaves to any extent this plan will

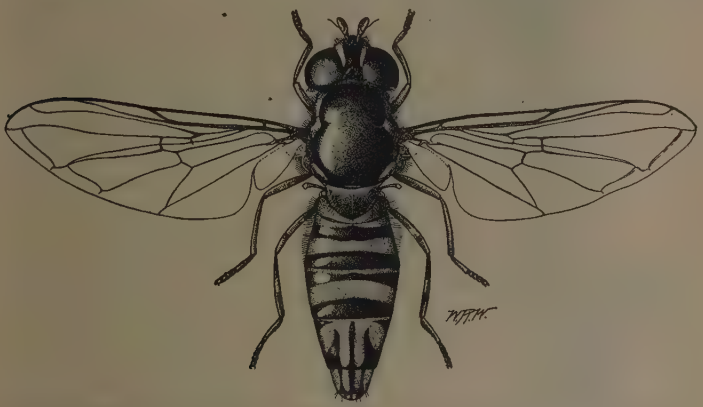

FIG. 27.—The adult syrphid fly *Allograpta obliqua*. Much enlarged. (Davis.)

be satisfactory. It is a question for the grower to decide whether under his conditions danger of aphid injury, especially by the leaf-curling species, makes the bud application desirable or whether this danger is so small that he is warranted in taking chances on the insects becoming troublesome. Examinations of the plants to determine the abundance of winter eggs and young stem-mothers on the opening buds should be of assistance in this connection.

SPRAY FORMULAS.

COMMERCIAL NICOTINE SOLUTIONS.

Aphids are killed by surprisingly small quantities of nicotine in water, and because of the entire safety with which it may be applied to plants nicotine is better suited than other sprays to control these insects. While the cost of the concentrated article is high, the ex-

FIG. 28.—A colony of the black peach aphis on peach twig heavily infested by a species of parasitic four-winged fly. Enlarged. (Original.)

tent to which it may be diluted makes the spray compare favorably in cost with other contact sprays. Nicotine is extracted from refuse tobacco, principally stems, by different commercial concerns, and is put on the market in several grades and strengths. The 40 per cent nicotine sulphate is the solution principally used, although weaker grades of nicotine may be employed provided care is taken that the spray be made so as to contain not less than 0.05 or 0.06 per cent of actual nicotine.

Nicotine may be added either to the winter-strength lime-sulphur solution for the San Jose scale or to the dilute lime-sulphur solution and arsenate of lead spray employed in the control of insects and diseases of fruit and foliage. It may also be used in Bordeaux mixture and arsenate of lead spray without interfering with its effectiveness or in an arsenate of lead, milk of lime, and water spray. In orchard spraying the 40 per cent nicotine sulphate is used at the rate of about three-fourths of a pint to 100 gallons of water, lime-sulphur solution, or Bordeaux mixture. When used in water the addition of soap at the rate of 4 or 5 pounds to 100 gallons adds much to its spreading power and efficiency. Soap should not be used with lime-sulphur solution, but may be used in Bordeaux mixture. Where only a small quantity of spray is required the nicotine sulphate may be used at the rate of 1 teaspoonful to a gallon, or 1 ounce to 8 gallons of soapy water.

HOMEMADE NICOTINE SPRAYS.

Where tobacco stems or refuse tobacco are available it is practicable

to make nicotine sprays at home. Owing to the variation in nicotine content of tobacco refuse, there is danger of having the spray too weak on the one hand or stronger than necessary on the other.

The following table, adapted from Bulletin 208 of the Virginia Agricultural Experiment Station, illustrates the variation in nicotine content of tobacco stems, refuse, and various kinds of tobacco, and may serve as a guide to those planning to make decoctions from tobacco refuse at home:

Formula for making nicotine extracts.

Lab. No.	Kind of tobacco.	Where from.	Nicotine.	Number of pounds per 100 gallons necesary to make solutions containing different percentages of nicotine.	
			Per cent.	*0.06 p. ct.*	*0.05 p. ct.*
1	Light stems	Richmond, Va	0.481	145	121
2	do	Danville, Va	.609	110	91
3	Sweepings	do	.884	74	62
4	N. L. Orinoco	Appomattox, Va	5.535	12½	10½
5	Olive	Powhatan, Va	3.367	19½	16½
6	Light	Danville, Va	2.984	22	18
7	Sweepings	Louisville, Ky	.753	91	85
8	Smoker	Chatham, Va	2.306	28½	23½
9	Wrapper	do	3.05	21½	18
10	Cutter	do	3.466	19	15
11	Dark	Appomattox, Va	2.835	23½	19½
12	N. L. Orinoco	Bowling Green, Va	5.629	11¾	10
13	Medium smoker	Chatham, Va	3.766	17½	14½
14	Common smoker	do	2.47	26	21½

Tobacco decoctions can be made conveniently in a lime-sulphur cooking plant, being heated either by steam or by fire under open kettles. The proper quantities of refuse tobacco and water should be placed in the container and the water heated to about the boiling point, after which it should be allowed to cool. Where steam is used a slight increase in water will occur, and a slight decrease where fire is used, although the variation usually will be negligible. Heating the decoction by either method may result in a slight loss of nicotine, especially if the water is allowed actually to boil.

Another method is simply to soak the tobacco refuse in water for 24 hours with frequent stirrings, using a barrel, vat, or other suitable container. This method removes about the same amount of nicotine (70 to 80 per cent) as does the heating process. After the heating or soaking has been completed the decoction should be strained to remove fragments of leaves, etc., and if pressure can be applied to the mass of refuse some additional liquid will be obtained.

Reference to the table will indicate the amounts of several types of refuse which should be used to produce an effective aphid spray. Probably in most cases the refuse at hand can be considered as belonging to some one of the types indicated in the table. Observa-

tions as to the effectiveness of the spray should be made, however, so that it may be strengthened if needed.

In this connection it should be remembered that the stems from which the extract has been made have a value for fertilizer purposes of about $10 per ton. With tobacco refuse and stems costing about $20 per ton, the spray solution will cost approximately 1 cent per gallon, the fertilizer value of the extracted refuse covering the cost of labor, etc., in the preparation of the spray.

Tobacco sprays should be made up as needed, since after a day or so fermentation begins.

SOAP WASHES.

Washes made of fish-oil[1] or laundry soap are effective against aphids, and are especially suitable for use on a small scale where only a few plants are to be treated, although fish-oil soap washes are used by many orchardists in the treatment of aphids, the pear Psylla, etc., and compare favorably in cost and effectiveness with nicotine and kerosene emulsion sprays. Both potash and soda fish-oil soaps are on the market. Potash soap is softer and hence there is less trouble in dissolving it in water. Soda soap usually must be sliced and dissolved in hot water before use.

Fish-oil soap of different brands varies greatly in water content, so it is not possible to indicate the precise quantity of soap to be used with a given amount of water for all brands of soap. However, since a statement, on the label, of the amount of the active ingredients (soap) and the total inert ingredients is required by the Federal insecticide act of 1910, purchasers are advised of the amount of soap and water present. In general fish-oil soap should be used against aphids at the rate of 1 pound to from 5 to 7 gallons of water, depending upon the amount of water present in the soap.

KEROSENE EMULSION.

Kerosene emulsion is made up in stock solution according to the following formula:

Kerosene	gallons	2
Fish-oil or laundry soap	pound	½
Water	gallon	1

First the soap should be dissolved in a gallon of boiling water, and after the vessel is removed from the fire the coal oil should be added. Then the mixture should be agitated thoroughly for four or five minutes by pumping the liquid back into itself until it becomes a creamy mass and the oil does not separate. The quantities of the ingredients

[1] The name "fish-oil soap" is now used in place of "whale-oil soap," since most of the soap on the market is made of fish oil.

may be increased when a larger quantity of spray is needed. This stock solution is used against aphids at the rate of 1 gallon to 7 or 8 gallons of water. Kerosene emulsion should not be added to a lime-sulphur spray.

SPRAYING FOR APPLE APHIDS.

Experiments made by the Bureau of Entomology and several of the agricultural experiment stations, notably those of Colorado and Oregon and the Geneva, N. Y., station, show that the aphids attacking the fruit and foliage of the apple are best controlled by spraying in the early spring just as the buds are breaking to destroy the stem-mothers. At this time the insects are hatching from the winter eggs, and are so exposed that one thorough treatment should destroy from 95 to 98 per cent of them and prevent their increase to such an extent that they will not cause serious injury later in the season. This applies especially to the oat aphis, the rosy aphis, and the clover aphis.

In the case of the green apple aphis, which lives on the apple throughout the year, the suppression of stem-mothers in the spring does not always guarantee freedom from this insect during midsummer, and supplementary treatments sometimes are desirable. In the case of young orchards, where the green apple aphis is principally to be considered, the bud spray should be given, but additional applications should be made in summer if found necessary.

Figure 29 illustrates the condition of apple buds when the first spraying should be done, and figure 30 shows the buds too far advanced for successful work, as the aphids have penetrated the spreading leaves and are very hard to reach. In the bud spray the nicotine may be used in the winter strength lime-sulphur solution employed for the San Jose scale, thus effecting the control of both insects by the one application. If the bud spray has been omitted and the aphids are present in numbers, 40 per cent nicotine sulphate should be used in the dilute lime-sulphur solution which is used for the first scab spray and also for the codling moth spray following the dropping of the blossoms. These later applications, however, are not nearly so valuable as the bud spray and merely serve to check the insects.

In spraying apple aphids very thorough work is essential, with good pump pressure, so that the spray may be driven as much as possible against the insects. Results in spraying will vary, depending upon the size of the trees as affecting the thoroughness of the application. On large trees results are frequently less satisfactory than on medium and smaller trees.

Spraying in the fall for the destruction of the fall migrants and the egg-laying females has been tried to a limited extent, but the adequacy of the treatment has not yet been proven.

Annual bud spraying of apple orchards would appear to be good practice, and over a series of years would no doubt prove profitable. This is especially true of varieties subject to "fruit spots" or "stigmonose," since these troubles have been shown by the Bureaus of Plant Industry and Entomology to be due, in part at least, to the activities of aphids.

FIG. 29.—Young stem-mothers of an apple aphid and condition of buds when the bud spraying should be given. Enlarged. (Original.)

CONTROL OF APHIDS ON PLUM, PEACH, CHERRY, ETC.

The several aphids which occur on plum, as well as the green peach aphis, pass the winter on the trees in the egg stage, hatching in the spring about the time when foliage appears. None of these species curls the foliage to the same extent as do some of the apple aphids, and thorough spraying of the trees when the insects are in evidence usually will be satisfactory. Nevertheless spring spraying against the stem-mothers is desirable in orchards where the insects have been troublesome regularly or where winter eggs are seen to be present in numbers.

The black peach aphis, which winters on the roots of the peach, should be treated as soon as the insects are observed to be present

on the foliage and twigs, and in regions where they are likely to be troublesome, as on nursery stock in sandy situations, careful watch should be made for their first appearance.

The black cherry aphis is likely to be in evidence each year on cherries. The insect winters on the trees in the egg stage and the eggs hatch somewhat in advance of the opening of the buds. Since this species causes a decided curling of foliage so that later treatments are not satisfactory, the effort should be made to destroy the stem-mothers as the buds are breaking.

FIG. 30.—Young apple shoot too far expanded for successful aphid spraying. Enlarged. (Original.)

DESTRUCTION OF WINTER EGGS.

Considerable experimenting has been done with sprays during the dormant period of trees to destroy the winter eggs of aphids (fig. 8), on the shoots, twigs, and branches. Thus far results have not been satisfactory, and while sprays may result in the destruction of some of the eggs, serious aphid injury occurs very frequently in orchards well sprayed for the San Jose scale.

In the course of pruning young trees it is often possible to remove many shoots covered with eggs, which should be destroyed.

CONTROL OF APHIDS ON CURRANT, GOOSEBERRY, AND GRAPE.

All of the important aphids attacking the currant and gooseberry pass the winter on these plants in the egg stage, the stem-mothers hatching as the leaf buds are opening and soon causing the leaves to become more or less pitted or curled. It is especially important, therefore, to spray as the shoots are pushing out, to destroy the stem-mothers before they are protected by the distorted foliage. In spraying for these insects later in the season the liquid should be directed upward to wet the insects on the underside of the leaves.

The grapevine aphis, while often abundant on the terminal growth, is rarely very injurious. It is much subject to parasitic and predatory

enemies, and migrates from the grape to Viburnum in early fall. When so abundant as to require treatment, any of the contact insecticides may be used.

CLEAN CULTURE.

As the reader will have learned, most aphids have a winter and early spring host plant, and from this they migrate to other plants, on which they subsist for several weeks or months during the summer. In most instances this alternation of food plants is essential to the life of the species, and in general the aphids are most troublesome in regions where alternate hosts are present in abundance. Often one or more of the host plants are of little or no economic importance in the locality, and in some cases are troublesome weeds. The destruction of worthless plants is desirable and should serve materially to reduce the aphids in question. Thus, in the case of the rosy aphis, the alternate food plants of which are species of plantain, the destruction of these in and about orchards is especially desirable, and should be a part of the remedial work against this pest in localities where it is more or less chronically injurious.

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